# GAP ANALYSIS OF THE ACTUAL VEGETATION OF CALIFORNIA 1. THE SOUTHWESTERN REGION

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ABSTRACT

Gap Analysis is a method of conservation risk assessment that evaluates the protection status of plant communities, animal species and vertebrate species richness by overlay of biological distribution data on a map of existing biological reserves. The National Biological Service has undertaken a national Gap Analysis that is being conducted by individual states but that will eventually produce regional and national assessments. Given California's size and complexity, we are conducting separate Gap Analyses for each of the state's 10 ecological regions, as delineated in *The Jepson Manual.* Here we summarize our findings on the distribution of plant communities and dominant plant species in the Southwestern Region of California, exclusive of the Channel Islands. We tabulate and discuss regional distribution patterns, management status and patterns of land ownership for 76 dominant woody species and 62 natural communities. Nineteen of 62 mapped communities appear to be at risk, as determined by their poor representation in existing reserves, parks or wilderness areas. Communities restricted largely to the lower elevations, such as non-native grasslands and coastal sage scrub types, are clearly at considerable risk. A majority of the lands at these elevations have already been converted to agricultural or urban uses and most of the remaining lands are threatened with future urbanization. Areas that appear to be of highest priority for conservation action based on agreement between our analysis and a recent assessment by The Nature Conservancy include the Santa Margarita River, San Mateo Creek, Miramar Mesa, Santa Clara floodplain near Fillmore, Sespe and Piru Canyons, and Tejon Pass.

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California's flora includes over 5800 native vascular plant species, or roughly 25% of the flora of the continental U.S. (Mooney 1988; Hickman 1993). One thousand four hundred and sixteen species (24.2%) and 737 subspecies or varieties are endemic to the state. During the past century this remarkable native flora has been seriously diminished by agricultural, residential and industrial development and by the spread of naturalized, alien plant species. Six hundred plant taxa and 200 natural communities are now considered endangered or threatened with extinction, and some 200 natural plant communities have been significantly reduced from their original distribution (Jones and Stokes Associates 1987; Jensen et al. 1990).

Considerable resources have been invested in conserving California's biodiversity on both public and private lands, which account for 51.5% and 48.5% of the state, respectively. Most efforts focus on single species or site specific issues, particularly in response to federal and state endangered species legislation. This piecemeal approach to conserving California's flora cannot possibly succeed, first because the economic cost is ultimately higher than the public is willing to bear, and secondly because of the inevitable fragmentation and cumulative degradation of habitats that accompanies localized impact mitigation schemes.

Most conservation biologists agree that the best strategy for conserving biodiversity is to maintain native species in extensive, natural landscapes that are sufficiently linked to allow interaction and genetic interchange among disjunct populations (Noss 1983). This requires a cohesive, representative system of areas managed for the maintenance of native biodiversity. (We avoid using the term "reserve" or "sanctuary" because management for maintenance of biodiversity does not necessarily preclude multiple-use land management strategies.) To implement such a system requires knowledge over regional to statewide extent of ecosystem patterns and dynamics, as well as species distributional status and trends, phylogeny, life history, and habitat requirements. It also requires more detailed, local information on population dynamics and genetics, as well as socioeconomic and political information. The broader-scale ecosystem assessment is sometimes referred to as the "coarse filter" approach to conservation planning, as opposed to the "fine filter" studies of individual species and localities.

In an effort to provide a coarse-filter perspective on biological diversity and its current conservation status, the National Biological Service is coordinating a national Gap Analysis program. The term "Gap Analysis" refers to the evaluation of the protection status of plant communities and terrestrial vertebrates by overlay of biological distribution data on a map of existing biological reserves using a geographic information system (GIS) (Scott et al. 1993). We are conducting a Gap Analysis of California with cooperation and collaboration from dozens of public and private organizations (see Acknowledgements). The analysis requires preparing a statewide map of actual vegetation, supplemented with more detailed locality data for plant taxa of special concern. Given the physiographic and biological complexity of California, we are conducting separate analyses for each of the state's geographical regions, as delineated in *The Jepson Manual* (Hickman 1993). Our hope is that this information will help to provide a regional context for more detailed, local investigations. Our intent is also to assist botanists, ecologists, and natural resource analysts in prioritizing community types and geographical areas for immediate, more detailed conservation assessments and actions.

This paper summarizes our findings on the distribution of plant communities and dominant plant species in the Southwestern Region of California, exclusive of the Channel Islands (Fig. 1). We describe the development of the database and illustrate its application to biogeographic research and conservation assessments. Dominant woody species and plant communities are tabulated in terms of regional distribution patterns, management status and patterns of land ownership. We test the hypothesis that land ownership and management status can be used to identify plant communities at high risk of becoming threatened or endangered, and find strong support for the assertion. Based on criteria that we develop to identify at-risk communities and species, we identify a number of widespread, upland plant communities and dominant species that we believe deserve more attention in conservation planning efforts. Finally, we combine maps of communities-at-risk with information from the Natural Diversity Data Base (NDDB) and The Nature Conservancy of California to locate and highlight areas that emerge as high priority for conservation planning and management.

## Study Area

*Geography.* The Southwestern Region includes 3,383,160 ha, roughly 8 percent of California. It lies within the California Floristic Province and is divided into four subregions and six districts (Fig. 1). Subregions include the South Coast, Channel Islands, Transverse Ranges and Peninsular Ranges. Districts of the Transverse Ranges include the San Bernardino Mountains, San Gabriel Mountains, and Western Transverse Ranges. The San Jacinto Mountains are considered a separate district of the Peninsular Ranges.

The region is bounded by the Sonoran Desert and Mojave Desert regions on the east and the crest of the Santa Ynez Mountains and the upper Cuyama Valley on the north. The boundary at the southern

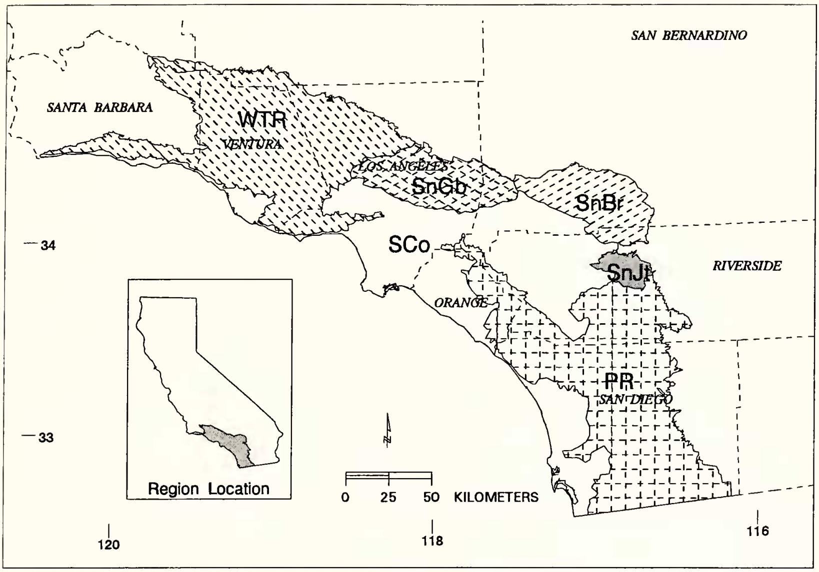


FIG. 1. Location map and geographic subregions of Southwest California defined on the basis of topography, climate, and plant community variation (Hickman 1993). We revised the northern boundary of the region, placing the upper Santa Ynez River basin and southern Sierra Madre Ranges in the Central Western Region. Subregions include the Transverse Ranges, which are further subdivided into the Western Transverse Ranges (WTR), San Gabriel Mountains (SnGb), San Bernardino Mountains (SnBr) and San Jacinto Mountains (SnJt), Peninsular Ranges (PR), and South Coast (SCo).

end of the region is defined as the Mexican border, although vegetation similar to that found in southwest San Diego County extends south into Baja California for roughly 300 km, where there is an abrupt transition to a more arid adapted flora (Westman 1981).

Based on 1990 census data, 16,539,858 people (56% of California's total population) reside in the region. This region has experienced extraordinarily rapid population growth in recent decades. From 1980 to 1990, the population of San Bernardino and Riverside counties grew at a rate of more than 50%, San Diego County grew at a rate of 30–40%, Orange and Ventura counties expanded by 20–30%, and Santa Barbara and Los Angeles counties grew 5–20% (Goodenough 1992). The population of some localities such as Vista and San Marcos in San Diego County grew by more than 100% over this period (Griffin 1992).

*Physiography and geology.* Forty–six percent of the region is lower than 500 m above mean sea level. Only 3.5% of the region is above 2000 m, and <0.1% is above 3000 m. The southern half of the region is dominated by the Peninsular Ranges. The northern portion of the region is part of the complex Transverse Ranges province. At least five main mountain ranges comprise the Peninsular Ranges of southern California: the San Jacinto Range (summit elevation 3325 m), the Santa Rosa Range (2680 m); the Santa Ana Mountains (1755 m); the Agua Tibia Mountains (1880 m) and the Laguna Mountains (1940 m). The basement rock of the Peninsular Ranges is a granitic batholith, consisting mainly of quartz diorite dating from the lower Cretaceous period (Norris and Webb 1990). Some older roof pendants remain, particularly in the western region, consisting of altered schist and gneiss, with some limestone. Major fault valleys include the Elsinore fault zone and the San Jacinto fault zone.

The major mountain ranges of the Transverse Range include the Santa Ynez Mountains (1325 m), the Topatopa Range (2060 m), the Santa Monica Mountains (925 m), the San Gabriel Mountains (3080 m) and the San Bernardino Mountains (3385 m). The San Gabriel and San Bernardino are mainly granitic and metamorphic rocks from the lower Cretaceous. The Santa Monica Mountains are comprised largely of Miocene marine sedimentary rocks and volcanic rocks, whereas the Santa Ynez and Topatopa mountains are predominantly Eocene interbedded marine sandstones and shales.

*Climate.* There is a strong climatic gradient from low coastal areas to high elevations of the interior, and a secondary gradient from north to south (Bailey 1966). Mean temperatures along the coast range from around 5°C in winter to 10°C in the summer. In contrast, mid-elevations further east range from 2°C in winter to 22°C in summer. Annual precipitation averages 250–500 mm at lower elevations to greater than 1500 mm at high elevations in the Transverse Ranges. Total annual precipitation at coastal localities decreases from 400 mm in the north to 250 mm at San Diego. However, southern areas receive more summer precipitation associated with tropical hurricanes. Annual moisture balance ranges from a surplus of 100–200 mm in the mountains to deficits of 200–600 mm at lower elevations. Within the region, topography and variable coastal influence combine to produce at least 5 general climatic types, including warm steppe, warm mediterranean, cool mediterranean, maritime mediterranean and microthermal (montane).

*Soils and vegetation.* Soil patterns are very complex, reflecting interactions among geology, topography, climate, geomorphology and vegetation. In general, mollisols predominate in the interior faulted valleys, while a diverse group of alfisols occur on the terraced coastal sediments. The mountain soils are not well characterized, but are likely to be comprised of poorly developed, excessively drained entisols. The California Natural Diversity Data Base (NDDB) system currently recognizes 272 natural communities occurring in the state (Holland 1986). Of these, 89 (33%) occur within the Southwestern Region. A list of 87 widespread trees and shrubs that are frequent canopy dominants in upland vegetation of the region are provided in Appendix A. Appendix B lists 73 communities that we have mapped, as well as 11 other community types described by Holland.

Upland natural areas of this region are dominated by 24 major terrestrial community types. Annual grasslands, woodlands and soft chaparral communities dominate lower elevations, giving way to hard chaparral at mid-elevations, and then to mixed evergreen forest and mixed conifer forest at the highest elevations. Slopes adjacent to the Mojave and Sonoran Deserts support drier shrubland types, as well as pinyon and juniper woodlands.

*Taxa of special concern.* NDDB lists 93 plant species, 28 subspecies, 26 plant varieties, and 34 terrestrial plant communities of special concern within the region. As of 1990, 4255/18,937 (25.5%) of all NDDB records fell within this area. High concentrations of threatened and endangered species occur near the coast in western San Diego County (Imperial Beach, Otay Mesa, Del Mar quads), near Cuyamaca Peak, in the Lake Mathews Basin, and near Big Bear Lake in the San Bernardino Mountains.

*Land ownership.* Sixty percent of the land area is in private ownership, much of it at lower elevations and already converted to urban or agricultural uses. Only a small fraction of private land is managed for biodiversity protection, including The Nature Conservancy preserves and Audubon Society sanctuaries. The steeper, montane areas are largely managed by public agencies such as the U.S. Forest Service (29% of the region), Bureau of Land Management (3%), Department of Defense (2%), and the California Department of Parks and Recreation (2%). Lands owned and managed by Native Americans cover only 2% of the region, mainly in San Diego County.

Four National Forests (from south to north, the Cleveland, San Bernardino, Angeles, and Los Padres) are managed primarily for watershed conservation, recreation, and fire protection. Congress passed legislation in 1964, 1968, 1984, and 1992 designating twelve wilderness areas on these National Forests. Similarly, California Parks and Recreation has designated four wilderness areas that lie wholly or partially within the region. The National Park Service, State Parks, and private conservancy groups are actively purchasing land in the Santa Monica Mountains National Recreation Area to preserve the area for recreational and natural values.

## Methods

*Vegetation classification and mapping.* The national Gap Analysis program is mapping actual vegetation to the formation level based on the UNESCO classification system (Jennings 1993), and to Series within these formations based on dominant or co-dominant overstory species.

For this study we identified vegetation types by one to three overstory species, each contributing greater than 20% of relative canopy cover. The 20% cover criterion, which we selected to be consistent with the California Vegetation Type Mapping (VTM) survey (Wieslander 1946; see Colwell 1988, for overview), is lower than typically applied to define canopy dominance. For example, the CALVEG classification defines dominant as >50% (Parker and Matayas 1981). Paysen et al. (1980) define Series based on a single dominant overstory species or genus. The ongoing California Native Plant Society Community Inventory is identifying Series primarily based on a single, overstory dominant, although a few series are based on two co-dominant species, and others are defined by environment (e.g., Alpine Series) (Sawyer 1993). For our purposes and at our 1:100,000 mapping scale, we found that use of single canopy dominants to type vegetation produced an unacceptable simplification of vegetation composition and pattern. For example, much of the chaparral vegetation in the Southwest Region would be mapped as Chamise or Scrub oak chaparral, masking systematic, regional variation in community composition. By using the 20% cover threshold, we retained information on one to three, and rarely four, canopy species that are dominant or co-dominant over several-to-many hectares. This area is much larger than plot sizes used in traditional vegetation studies. To avoid confusing these vegetation types with Series or Associations as defined by other systems, we refer to these combinations as *Species Assemblages.* In the field, species in an assemblage may be uniformly mixed or in a fine mosaic of patches, depending on the scale at which the pattern is observed. This means that in practice, species assemblages in our database can be a series recognized by existing classification systems, a combination of two or three recognized series, or previously unrecognized species combinations.

A map of actual vegetation was produced using summer 1990 Landsat Thematic Mapper (TM) satellite imagery, 1990 high altitude color infrared photography (1:58,000 scale), VTM maps based on field surveys conducted between 1928 and 1940, and miscellaneous recent vegetation maps and ground surveys. Details of the mapping process are provided in Davis (1991), and are only summarized here.

We did not have the resources to map individual stands of homogeneous vegetation. Instead, we have attempted to delimit "landscapes," which we defined as areas of one to many square kilometers in extent with uniform climate, physiography, substrate and disturbance regime, and covered by a single species assemblage or by a mosaic of a few species assemblages associated with different sites (e.g., riparian zones, mesic slopes, xeric slopes). Landscape boundaries were mapped subjectively by photointerpretation of patterns in the satellite imagery. Final delineation of a landscape unit was an iterative process based on evidence from the satellite imagery, 1990 air photos, existing vegetation maps and field reconnaissance. The map was produced using a minimum mapping unit of 100 ha (1 $km^2$), and the region was mapped into 2014 landscape units, or polygons.

TM imagery was resampled to the Albers equal-area projection with 100 meter resolution (i.e., 1 hectare pixels), and a false color composite of red, near-infrared and mid-infrared reflectance images was displayed on a video monitor. Obvious landscape boundaries were digitally drafted over the imagery based on image tone and texture. Ancillary information, especially air photos and VTM maps, was used to capture additional compositional changes in vegetation that were not visually obvious in the TM imagery. VTM maps were used to position landscape boundaries on vegetation gradients where no obvious break was visible on either the satellite imagery or in air photos. Two hundred and thirty polygons (excluding urban and agricultural areas) were checked in the field, primarily by roadside reconnaissance.

Using these various sources, a large amount of information was collected for each landscape unit (Table 1). Based on our concept of landscape, we recorded a primary species assemblage, which was the most widespread vegetation type or land use/land cover type in the polygon, a secondary type, and the fraction of the landscape covered by each type. We also recorded the most widespread wetland assemblage, which was usually riparian vegetation. Each species assemblage was defined by up to three dominant species. We also recorded the occurrence of minor overstory species of special conservation concern (e.g., *Juglans californica, Quercus engelmanii, Cupressus forbesii*).

Species data were derived from field survey, air photos or from the VTM maps. VTM information was used for areas where air photos provided no evidence of recent disturbance, based on the assumption that canopy dominants observed by VTM field crews have not changed over the past 50–60 years. We realize this is a tenuous assumption. We found during our field surveys that the assumption is usually valid for forest and hard chaparral types. Although the relative dominance of species may have changed over the interval, species that were mapped as co-dominants by VTM crews in the 1930's are still canopy dominants across the same landscape. The composition of soft chaparral and grassland types is not as stable over the same interval, and we made special efforts to view these types in the field or to find more current maps. Our

TABLE 1. DATA COMPILED FOR EACH VEGETATION MAP UNIT AND USED TO DERIVE MAPS OF SPECIES' DISTRIBUTIONS, NDDB PLANT COMMUNITIES, AND GAP ANALYSIS SPECIES ASSEMBLAGES.

| |
|---|
| Polygon ID, number |
| Primary vegetation |
| Dominant species 1 |
| Codominant species 2 |
| Codominant species 3 |
| Canopy closure (4 classes) |
| Fraction of polygon occupied by primary type (10% intervals) |
| Secondary vegetation |
| Dominant species 1 |
| Codominant species 2 |
| Codominant species 3 |
| Canopy closure |
| Fraction of polygon occupied by type |
| Presence/absence of 9 wetland habitat types (CA WHR types) |
| Primary wetland vegetation |
| Dominant species |
| Codominant species 1 |
| Codominant species 2 |
| Presence of canopy species of special status (narrow endemics, RTE species) |
| Evidence of disturbance (5 categories) |
| Source map(s) used in interpretation |
| Air photo ID number |
| Field visit |
| Analyst |

landscape units are many square kilometers in extent, and canopy composition can vary greatly from site to site within a landscape. Thus the species assemblages that we have mapped record those species that most frequently dominate most sites in that landscape.

We have tried to account for fire dynamics by recording recent burns and by retaining information on the pre-burn dominants (e.g., an area of recently burned chamise chaparral that is presently dominated by herbs would be recorded as sparse chamise canopy codominated by annual herbs).

Rather than a multi-colored vegetation map, the information we have developed is better treated as a vegetation database linked to a set of areas. One can retrieve distribution data on individual species, unique combinations of species, or vegetation types defined by physiognomy and/or composition (Stoms et al. 1992). Although the database approach provides a more flexible framework for representing vegetational variation than the traditional vegetation map, it does not eliminate the need for classification in order to simplify and communicate results. We recorded 1013 unique species (or species/landuse) combinations in 2100 polygons. Many unusual species combinations occurred at the margins of the region in transitional environments. Here we summarize distribution data for individual dominant species and based on plant communities as defined in the California NDDB (Holland 1986), which we derived from the database by an equivalence table assigning each species combination to a unique NDDB community. The criteria for class assignment in the NDDB classification system are qualitative and often not explicitly based on dominant overstory species. Where ambiguities existed, we assigned species combinations to more general types. For example, Holland (1986) identified four Sage Scrub community types (Venturan, Diegan, Diablan and Riversidian) that we necessarily aggregated into a single type.

*Map accuracy assessment.* Map accuracy can be assessed in many different ways, most commonly by comparing the map to ground observations for a set of sample "points" (Congalton 1991). This approach is not practical for small scale maps such as ours because of the sampling effort required to determine the actual map class at a point on the ground when the minimum mapping unit is 1 $km^2$. The size and limited accessibility of some parts of the study area also pose considerable financial and logistical challenges. For these reasons, we have not conducted a formal assessment of the accuracy of the vegetation database. Instead, we have attempted to provide a qualitative measure of map accuracy through roadside reconnaissance and by comparing our map with recent detailed vegetation maps that have been prepared for parts of the region. As noted above, 230 polygons were checked in the field. Less than 5% of the polygons that were visited needed replacement of the Primary or Secondary Series. Roughly one-half of the polygons required minor adjustments, such as a reversal of Primary and Secondary Series, or addition or deletion of a canopy co-dominant.

We compared our vegetation data to large scale vegetation maps that had been extensively field checked and were not used in preparing the Gap Analysis map. For instance, we compared our Coastal Sage Scrub Series to a map prepared with a 1 ha MMU by Regional Environmental Consultants (RECON) for coastal San Diego County (Stine et al. in press). RECON mapped 1625 stands of coastal sage scrub, compared to 105 landscapes containing coastal sage scrub in the Gap Analysis map. Ninety-nine % of coastal scrub in patches larger than 100 ha was represented in both maps. One thousand three hundred, eighty-three RECON polygons fell outside landscapes that we had mapped as containing Coastal Sage Scrub. However, nearly all of these RECON polygons were small fragments of coastal sage scrub in urban or agricultural landscapes, and 75% were smaller than 10 ha, thus falling well below the grain size of our analysis.

We have also compared our map to very detailed vegetation maps (MMU <0.25 ha) prepared for southwestern San Diego County as part of the Multi–Species Conservation Planning (MSCP) program (Ogden Environmental and Energy Services 1993). A comparison of 138 random points on the two maps shows 87% agreement (i.e., either Primary or Secondary designation of the Gap map is in accord with the MSCP designation) and only 5% are larger polygons (i.e., >10 ha) that disagree.

In summary, the vegetation database has inaccuracies but is generally in high agreement with other, recent vegetation maps. However, it is a highly generalized abstraction of vegetation pattern that can serve only for broad regional assessments and inventories. The database is being distributed in both digital and analogue form to local botanists and we fully anticipate that the map will undergo periodic revision based on feedback from local experts. Those revisions should not significantly affect the general results reported here.

*Land management.* All lands are managed by humans, and these management activities can be of primary importance in determining the status and trends in species and communities. Unfortunately, ecologically meaningful information on management activities is difficult, if not impossible, to obtain for many areas of the state. In the absence of better information, we have used land ownership and administrative designation as surrogates for management. For the purposes of Gap Analysis, we distinguish three levels of management (modified from Scott et al. 1993):

*Level 1 management*: An area with biodiversity conservation as a defined management objective, that is essentially maintained in its natural state and within which natural disturbance events are either allowed to proceed without interference or are mimicked through management (comparable to the California Heritage Division's Protected and Semi-Protected designations). Examples include national parks, TNC reserves, federal wilderness areas, U.S. Forest Service Research Natural Areas, and BLM Areas of Critical Environmental Concern.

*Level 2 management*: Most non-designated public lands, including National Forests, military lands, county parks, and so on. Legal mandates prevent permanent conversion to anthropogenic habitat types (with some exceptions, such as tree plantations) and confer protection to populations of federally listed and/or candidate species. Habitats are potentially subject to competing consumptive uses. Sites generally have a manager or managing agency capable of protecting elements of biodiversity. (Heritage Division designation, Unprotected.)

*Level 3 management*: Other private lands without existing easement or irrevocable management agreement that maintains native species and natural communities, and which are managed primarily or exclusively for intensive human activity. The Heritage Division does not define this category.

In collaboration with the California Department of Fish and Game Natural Heritage Division, we developed a map of land ownership at a scale commensurate with the objectives of Gap Analysis (200 ha minimum mapping unit for most areas, 80 ha for coastal and wetland reserves) (Beardsley and Stoms 1993). The base map is land ownership as portrayed in 1:100,000 Bureau of Land Management Surface Management Status maps. A statewide, digital coverage was provided to us by the Teale Data Center. We updated this coverage to reflect recent changes in land ownership, and then added administrative boundaries of managed areas such as wilderness areas and research natural areas. To determine these boundaries, we consulted National Forest maps and USGS topographic maps, and contacted many agencies, conservation organizations, and land trusts. Information tabulated for each mapped ownership/managment unit includes managing agency, management level with respect to biodiversity conservation, a managed area code assigned by the Heritage Division, the source of the digital boundary lines, and the date of establishment.

*Identifying species and communities at risk.* The premise of Gap Analysis is that biological resources at risk can be identified by their ownership/management profile as generated by GIS overlay of 1:100,000 scale maps. To test this premise, we compared the ownership profiles of plant communities that are considered at risk by the Natural Heritage Division of the state Department of Fish and Game. Using a look-up table to classify our map units into NDDB community types, we derived 64 mapped communities (out of 89 recognized in the region), 61 of which occupied more than 2 square kilometers in our representation. The proportion of each community's distribution in Level 1 management versus private land is shown in Figure 2. The mapped distribution of threatened upland types is significantly different than the types in general. All show less than 10% of the distribution in Level 1 Management, and 5/6 show at least two-thirds of their current extent on private lands. Six threatened wetland types are less distinctive, as would be expected given the scale of the vegetation map. Nevertheless, threatened wetland communities also show the same general pattern of being predominantly on private lands and with little representation in existing Level 1 managed areas.

These results reinforce the caveat stated above that Gap Analysis data are not appropriate for assessing highly localized community types and widespread types that typically occur in small patches, such as many wetland types. However, Figure 2 supports our premise

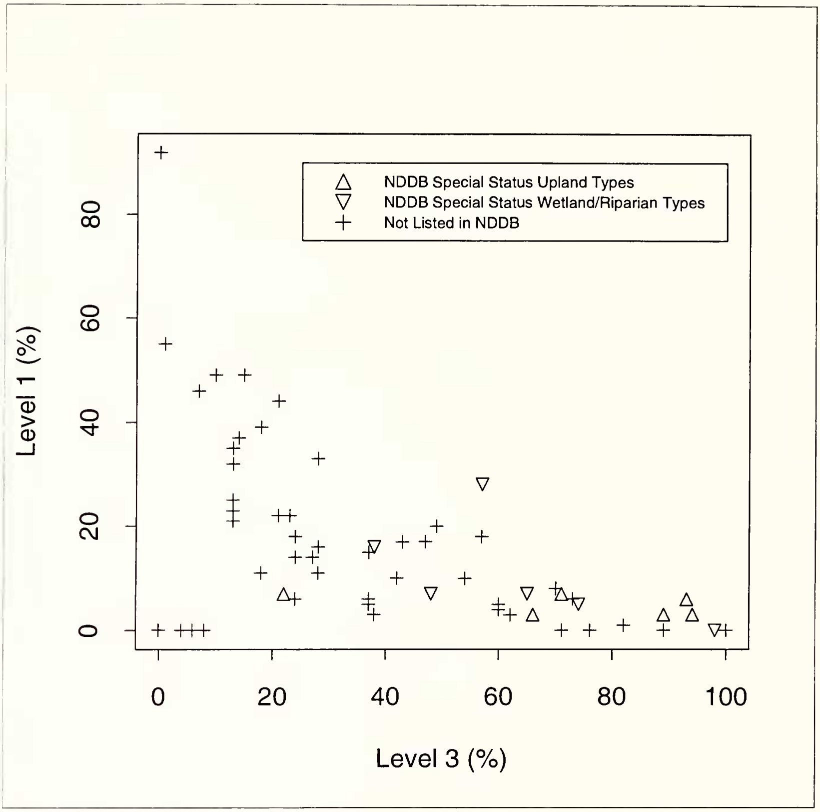


FIG. 2. Plot of the proportion of 64 Natural Communities, as defined by Holland (1986), in Level 1 (managed primarily for biodiversity) versus Level 3 (unrestricted private lands). Diamonds identify those communities that are considered by the Heritage Division of California Department of Fish and Games to be threatened or of special concern.

that the Gap Analysis approach can be used to identify more widespread upland plant communities at risk. Guided by these results, we adopted the following criteria for identifying communities at risk:

1. Less than 10% of the mapped distribution is in Level 1 areas, and the species or community type is endemic to the region, and the mapped distribution covers more than 100 km$^2$,

**or**

2. over 70% of the mapped distribution is in Level 3 areas.

## RESULTS

*Land ownership and management.* Fifty-four Level 1 managed areas were identified that meet the minimum mapping unit size in

TABLE 2. AREA BY MANAGEMENT LEVEL IN THE SOUTHWESTERN CALIFORNIA REGION. (Source: California Gap Analysis Database.) Also tabulated are the area and management status of areas mapped as Significant Natural Areas (SNA's) by the Interagency Natural Areas Coordinating Committee (data courtesy of the State of California Natural Heritage Division, Department of Fish and Game). Discrepancy in Total from the sum of Level 1 through 3 is due to small managed areas whose area is below the minimum mapping unit (MMU) of 200 ha.

| Level | All land area (in ha) | Percent of total land area | SNA's area (in ha) | Percent of total SNA area |
|---|---|---|---|---|
| Level 1 | 330,655 | 9.8% | 57,008 | 12.1% |
| Level 2 | 1,030,531 | 30.5% | 125,682 | 26.7% |
| Level 3 | 2,021,197 | 59.7% | 287,212 | 61.1% |
| Total | 3,383,160 | 100% | 470,407 | 100% |

the Southwestern California region. A large fraction of Level 1 land is National Forest Wilderness Areas, with 226,185 hectares in 14 areas. State Parks, including Reserves and Wilderness Areas, are the second largest category of Level 1 areas, totaling 56,204 hectares. In summary, Level 1 areas total 324,773 ha or 9.6% of the region. 30% of the region is other public lands managed at Level 2, while the remaining 60% is Level 3 (Table 2). Roughly 47% of Level 3 lands support natural vegetation cover, while the remainder were mapped as urban, residential or agricultural.

From the "date of establishment" attribute in the database, we were able to compile a picture of the increase in Level 1 managed areas over time. Roughly one-quarter of the current Level 1 managed area was established prior to 1960. The wilderness system was expanded during the 1960's, again in 1984, and most recently in 1992 with the designation of several large wilderness areas in Los Padres National Forest.

Management status differs systematically among elevation zones. Elevations below 1500 m (89% of the region), where most urban and agricultural development are located, are predominantly private land, whereas elevations between 1500 m and 2500 m (10% of the region) are primarily public lands, mainly in Level 2 management. The majority of land above 2500 meters is in level 1 management, and in fact more than 90 percent of the highest elevation zone is in Level 1 management (predominantly National Forest wilderness areas). However, lands above 2500 meters account for slightly less than 1% of the total region.

*Distribution and management status of dominant species and communities.*

1) Herbaceous vegetation—We were unable to distinguish herbaceous plant species and community types beyond very general

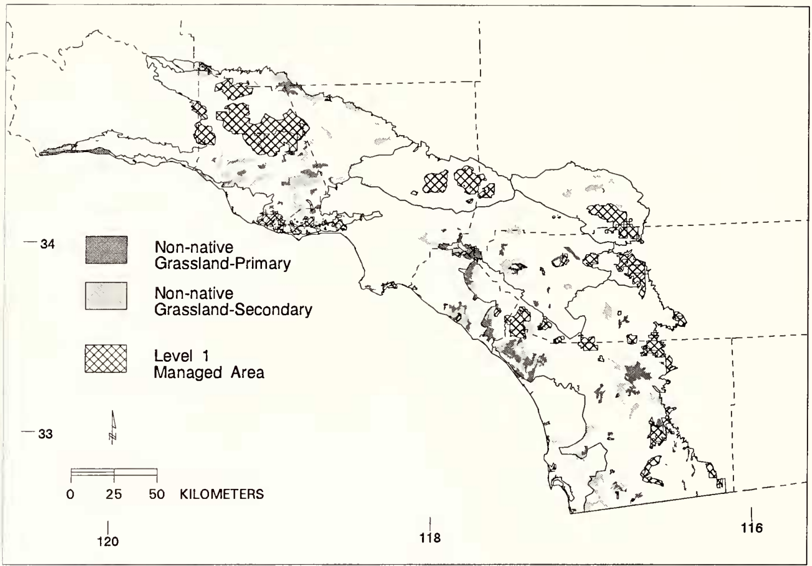


FIG. 3. Distribution of landscapes where Non-native Grassland (#42200) is the primary (dark shading) or secondary (light shading) upland vegetation type. Also shown are county boundaries (broken lines), geographic subregions (solid lines) and Level 1 managed areas (hatched pattern).

classes. For example, we classified practically all grasslands as "Non-native" despite the fact that many of these areas contain sizeable populations of native grasses and forbs. Thus our estimate of the extent of the Valley Needlegrass community is undoubtedly too low (Appendix B). Keeley (1990) provides a much more detailed assessment of the distribution and conservation status of native grasslands. However, we would call attention to the fact that nearly three–fourths of non–native grassland in the region is privately held, and only 6% is in Level 1 areas (Fig. 3). Although dominated by exotic species, these grasslands can be rich in native plant species and are habitat to many animal species. Recent efforts to preserve grassland habitats for the Stephens' kangaroo rat (*Dipodomys stephensi*) in the Riverside Basin attest the ecological significance of this community type. However, annual grasslands in other parts of the region are generally not considered a conservation priority. Our data suggest that from a regional perspective non-native grasslands appear to be at risk.

2) Sagebrush steppe species and vegetation types—Plant communities dominated by *Artemisia tridentata, Chrysothamnus nauseousus* or *C. parryi* occur along northern and northeastern margins of the region, and are concentrated in the upper Cuyama Valley,

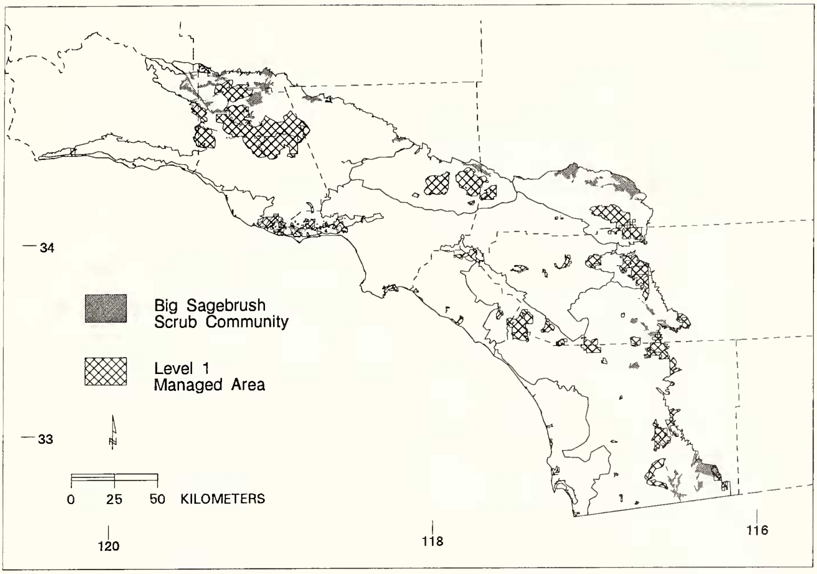


FIG. 4. Distribution of landscapes where the Big Sagebrush Scrub Community Type (#35210) is the primary or secondary upland vegetation type. Also shown are county boundaries (broken lines), geographic subregions (solid lines) and Level 1 managed areas (hatched pattern).

Lockwood Valley, eastern San Bernardino Mountains, locally in the Anza Valley, and in the extreme southeastern corner of the region (Fig. 4). Roughly 60% of the area occupied by sagebrush steppe is multiple-use public land, and less than 5% occurs in Level 1 managed areas. It appears that nearly all sagebrush steppe in the region is subject to grazing. Some areas area already the focus of conservation efforts aimed at protecting threatened and endangered species. For example, the Pebble Plains, in the northeastern San Bernardino Mountains, are habitat to candidate endangered species such as *Castilleja cinerea* and *Astragalus leucolobus.* Based on current land ownership and managed patterns, sagebrush steppe in this region appears to be at high risk and deserving of more conservation research and management.

3) Soft chaparral—All soft chaparral species and communities occur predominantly on private lands. Soft chaparral in California is largely confined to this region, although variations with different species composition extend north along the coast to beyond the San Francisco Bay. Once very common and widespread, particularly in the south coast subregion, the type has been fragmented and its extent reduced severely by development of coastal habitats (O'Leary 1990). Much conservation effort is focused on areas in Orange, Riv-

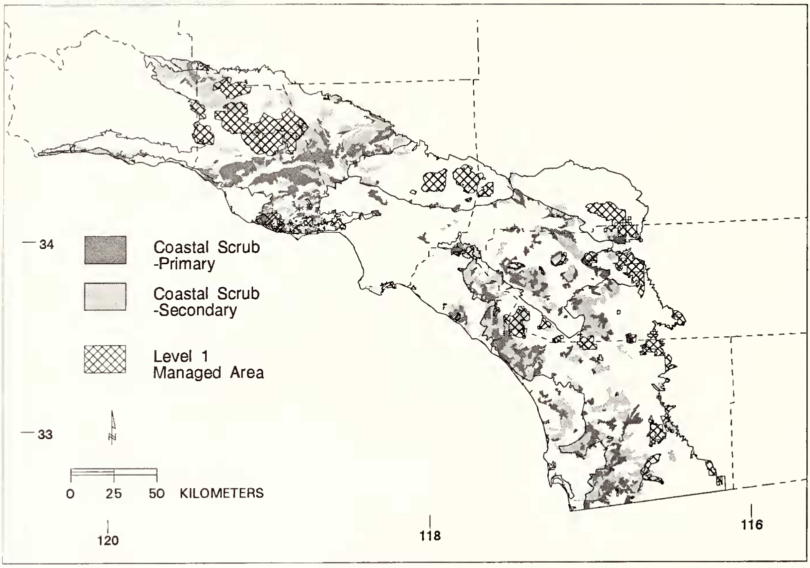


FIG. 5. Distribution of landscape where the Coastal Scrub Community Type (#32000) is the primary (dark shading) or secondary (light shading) upland vegetation type. Also shown are county boundaries (broken lines), geographic subregions (solid lines) and Level 1 managed areas (hatched pattern).

erside, and San Diego counties that are habitat for the threatened California gnatcatcher (*Polioptila californica*) (Brussard and Murphy 1992). Our analysis highlights the need to consider more northerly elements as well. For example, practically all landscapes dominated by *Salvia leucophylla* are in the western Transverse ranges, north of the current range of the gnatcatcher (Appendix A). Nearly all (87.3%) of the mapped distribution of this species is privately owned.

The CNDDB coastal scrub community is widespread (3908 km$^2$), but 71% is on Level 3 lands and only 7% is on Level 1 lands (Fig. 5 and Appendix B). We mapped 23 major coastal scrub species assemblages (not shown) over about 10% of the region, perhaps less than 15% of their historical coverage (Westman 1981). Soft chaparral dominated by *Artemisia californica* appears most at risk. Other coastal scrub types do not have much higher percent in protected status; the highest percentage in Level 1 (excluding *Yucca whipplei,* which has a very small coverage) is 7.1% for *Salvia apiana.*

4) Chaparral—Chaparral is the dominant and characteristic vegetation of this region. Seventeen natural community types and 64 species assemblages were identified covering over 12,057 km$^2$, about 36% of the current land cover of the region (including urban and agricultural lands). *Adenostoma fasciculatum* is the most widespread

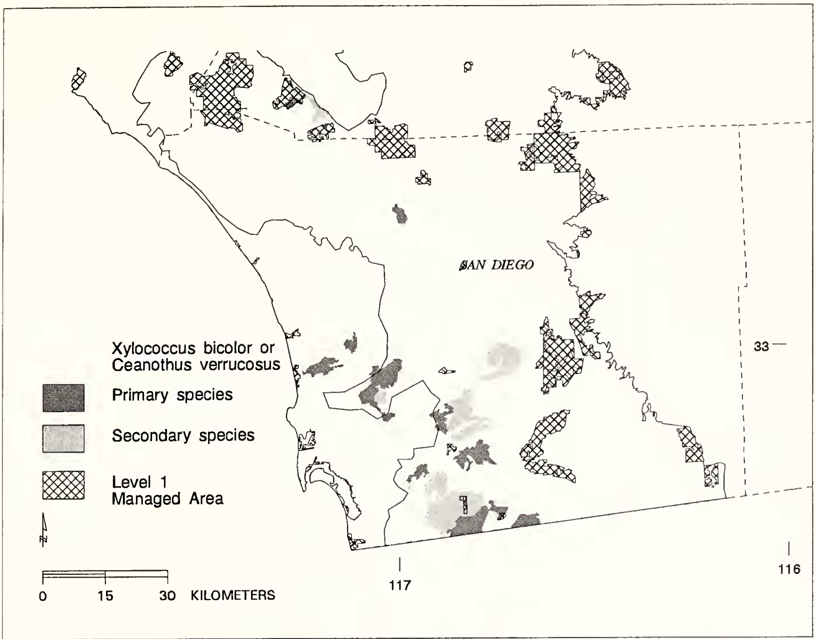


FIG. 6. Distribution of landscapes where either *Xylococcus bicolor* or *Ceanothus verrucosus* is the primary (dark shading) or secondary (light shading) upland vegetation type. Also shown are county boundaries (broken lines), geographic subregions (solid lines) and Level 1 managed areas (hatched pattern).

chaparral species in the region, occurring as a dominant or co-dominant on almost 8000 km$^2$. It is associated with a number of different species, the most frequent being *Ceanothus crassifolius, C. greggii, Adenostoma sparsifolium,* and *Arctostaphylos glandulosa.* Many of these assemblages show little overlap and are associated with specific subregions. For example, *A. fasciculatum/C. crassifolius* dominates mid-elevations of the San Bernardino, San Gabriel, and Santa Ana mountains. *Adenostoma fasciculatum/C. greggii* var. *perplexans* is widespread in the Peninsular Ranges, and *A. fascicículatum/A. sparsifolium* occurs extensively along the western slopes of the Santa Rosa Mountains and more locally in the Santa Monica Mountains.

The large majority of the chaparral species and communities appear to be either widespread and/or well represented (i.e., over 10%) in the Level 1 areas. Some taxa are also relatively uncommon and underprotected in this region (e.g., *Fraxinus dipetala* and *Ceanothus sorediatus* = *C. oliganthus* var. *sorediatus*). Several assemblages are both uncommon and underprotected, notably those containing *Xylococcus bicolor* and *Ceanothus verrucosus,* which occur at the southern end of the region (Fig. 6). The percent in Level 1 management for *X. bicolor* and *C. verrucosus* are 3.4% of 219 km$^2$ and <0.01% of 16 km$^2$, respectively.

We mapped 17 CNDDB chaparral types out of 22 known to occur in this region. Of the 5 remaining community types, Tobacco brush and Bush chinquipin chaparral are localized at higher elevations in this region. Poison oak chaparral is currently not well defined, although it is probably a more distinct entity north of this region. Southern maritime chaparral and Alluvial fan chaparral are restricted to this region. We were unable to map Southern maritime chaparral from our data using the description by Holland (1986), and the latter is too localized to be represented at our map scale.

5) Hardwood forest/woodland—There are five major hardwood woodland types characteristic of this region. *Quercus agrifolia* is distributed throughout the region and in association with a number of other co-dominant species. Most series types and the overall distribution of this species are poorly represented in protected areas, and conversion to urban land use appears to be one of the major causes of decline in these types (e.g., Scheidlinger and Zedler 1980). *Quercus engelmannii* is endemic to this region and is also significantly under-represented in Level 1 areas (Fig. 7). Recently Scott (1991) analyzed the geographic distribution of this species based on 1:24,000 maps that he prepared from air photos. He estimated that *Q. engelmannii* occurs over 31,500 ha, compared to our estimate of 23,600 ha. The discrepancy appears mainly due to the differences in map scale rather than classification, given that his mapped stands fall almost entirely within our mapped landscapes. Scott called attention to the poor representation of the species in existing reserves, a pattern that we also observed (<3.5% in Level 1 areas ), despite the recent establishment of significant new reserves such as The Nature Conservancy's Santa Rosa Plateau Reserve.

The various riparian woodland types are usually found in patches too small to be detected with the techniques employed by the Gap project. Nevertheless these types appear to be poorly represented (0.2 to 7.2%) in Level 1 areas. *Quercus chrysolepis,* and to a lesser extent *Quercus kelloggii,* are widely distributed in the region and throughout California, and generally well represented in Level 1 protected areas.

More localized woodland species include *Quercus lobata, Quercus douglasii, Quercus wislizenii, Arbutus menziesii,* and *Juglans californica.* While most of these species are more widely distributed in other regions of California, the southern California black walnut (var. *californica*) is almost entirely restricted to this region. The current distribution of this species is highly fragmented and almost entirely (89.3%) on private land, with remnant populations in the Santa Clara River drainage, Simi Hills, Santa Susana Mountains, Santa Monica Mountains, San Jose Hills, Puente Hills, and Chino

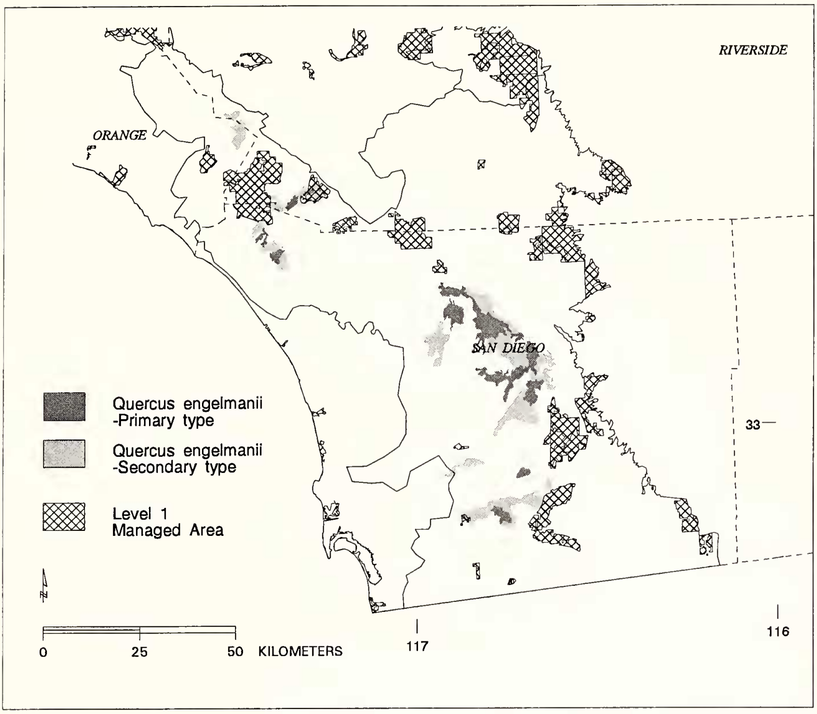


FIG. 7. Distribution of landscapes where *Quercus engelmannii* occurs as a canopy dominant or co-dominant in the primary (dark shading) or secondary (light shading) upland vegetation type (usually Open or Dense Engelmann oak woodland or Coast live oak woodland). Also shown are county boundaries (broken lines), geographic subregions (solid lines) and Level 1 managed areas (hatched pattern).

Hills. Quinn (1990) provides a detailed analysis of the distribution, ecology and conservation status of this type, and emphasizes the need for immediate conservation action in the face of imminent urbanization of many remaining habitats.

6) Conifer forest/woodland—*Pseudostuga macrocarpa* and, to a lesser extent, *Pinus coulteri* are largely restricted to and characteristic of this region. They generally occur from 500 m to 1500 m, but *P. macrocarpa* is concentrated in canyons and steep north-facing slopes, whereas *P. coulteri* occupies a range of topographic sites. Thirty four percent of the mapped distribution of *P. macrocarpa* is in Level 1 areas (Appendix A), and 40.7% of the widespread species assemblage, Big cone spruce/canyon live oak, is in Level 1 areas. 22.2% of the mapped distribution of *P. coulteri* is on Level 1 lands. At slightly higher elevations, *Pinus ponderosa, P. lambertiana,* and *Calocedrus decurrens* are well represented in Level 1 areas (38.1%, 41.8%,

and 13.3%, respectively), with the vast majority of the remaining distribution on Level 2 lands. Highest elevations are dominated by *Abies concolor, Pinus jeffreyi, Pinus contorta* var. *murryana,* and *Pinus flexilis.* These vegetation types are among the best protected types in the region, with 22.2% to 91.1% of mapped distributions in Level 1 areas.

*Pinus monophylla* and *Juniperus californica* are prominent at the region boundaries adjoining the Desert and Central Valley regions. Both appear to be reasonably well represented in Level 1 areas at 14.2% and 15.6%, respectively (Appendix A). The Pinyon pine/California juniper assemblage is widespread in the upper Cuyama Valley and in other parts of the Transverse Ranges, and has 23.4% in Level 1 areas. Most other lands that include these two species are in Level 2 management.

Several other coniferous forest species are found only peripherally in this region. *Pinus attenuata, P. sabiniana,* and *J. occidentalis* are rare here and more widespread in adjoining regions. Two endemic conifers, *Cupressus forbesii,* and *C. arizonica* ssp. *arizonica* are restricted to very local sites and difficult to detect using our method. Both are worthy of conservation attention based on existing information (Oberbauer 1990).

*Natural heritage division significant natural areas.* Significant Natural Areas (SNA's) are a designation of the California Fish and Game's Land and Natural Areas Program (LNAP) for locations with concentrations of rare or endangered biota. A SNA must meet at least one of three criteria: extremely rare elements of biodiversity, ensembles of three or more elements, or best examples of elements (Hoshovsky 1988). Some SNA's are mapped as circles drawn around a point where a rare element occurs rather than as irregular polygons drawn along natural or ownership boundaries. The LNAP has produced a digital map of the 1992 version of the SNA inventory that was provided to the California Gap Analysis project. An overlay of the Gap Analysis Management layer with the SNA map indicates that the percentage of SNA's in each level closely matches that of the region as a whole (Table 2). This is indicative of the fact that biological reserves have historically been established without systematic attention to their biotic composition. The primary opportunities for protecting SNA's on public lands are the national forests (14% of the total area in SNA's) and military bases (7.5% of SNA lands).

## Discussion

*Limitations of the methods.* Gap Analysis provides a regional overview of the distribution and ownership profile of major terrestrial plant species and communities. The method is not suited to the analysis of most wetland types, dune communities, or other communities that are restricted to very localized environments. The vegetation mapping technique is well suited to analysis of shrubs and trees, but provides little or no information on the distribution of herbaceous species.

Estimates of area made from maps are very sensitive to map scale and mapping methods. Our map is less sensitive because we have recorded proportions of types within polygons. Nevertheless, our estimates of the extent of species and types are only useful for comparing among types on our map, and are not the same as areas calculated from maps prepared at another scale. Similarly, our maps of vegetation and land ownership were prepared commensurately for direct overlay and comparison, but ownership profiles of vegetation types would be somewhat different if either map was prepared using a different minimum mapping unit.

Land ownership/management profiles provide a crude measure of risk of development or resource over-exploitation. Species and communities can also be at risk due to climatic change, introduced competitors and pathogens, and many other ecological factors. For instance, subalpine forests may be extremely well protected in the region but at high risk due to global warming. Furthermore, there is wide variation in land management practices within each of the three categories. Some private lands are well managed for the maintenance of plant diversity, but some reserves may be managed in a way that threatens the persistence of selected species. Private land management also depends heavily on zoning status, and county zoning data are required to conduct a fuller analysis of present and possible future management of private lands. We are presently collaborating with the Southern California Association of Governments to conduct such an analysis. Similarly, land management on public lands ultimately should be analyzed within individual administrative units (e.g., individual national forests), and we are distributing our data to federal and state agencies to support these more detailed analyses.

The static nature of the Gap Analysis data also limits their utility in conservation risk assessment. Our database provides a snapshot of a region in which land cover and land ownership are both very dynamic and where trend data would be especially useful. VTM survey data collected a half century ago provide some opportunity for such trend analyses, and we intend to pursue such comparisons, which must remain qualitative given the nature of VTM and Gap Analysis data. For example, Figure 8 shows such a comparison for *Artemisia californica* in the southeastern portion of the region. The species is greatly reduced from the distribution mapped in the 1930's, especially in the San Diego metropolitan area, the area from Lake Elsinore to Temecula, and the Riverside Basin.

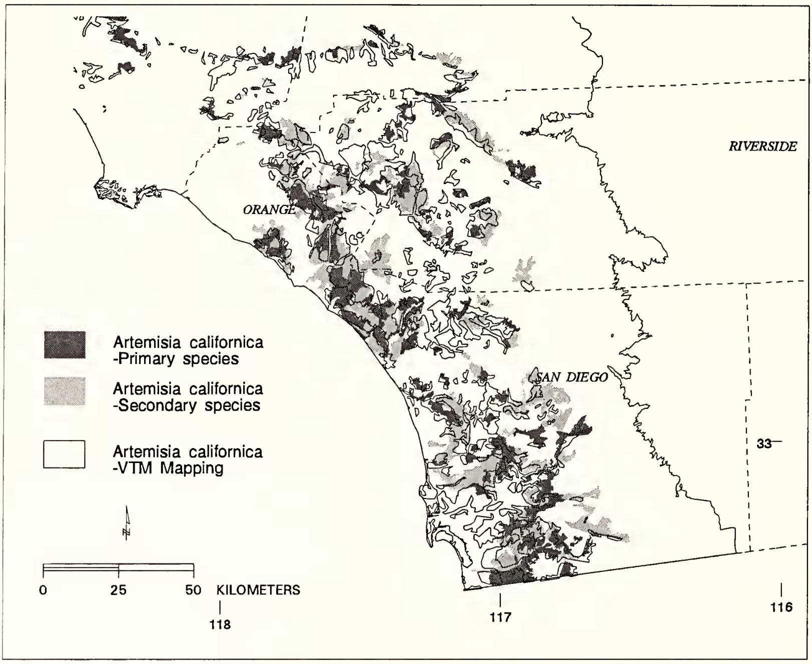


FIG. 8. Generalized distribution of *Artemisia californica* as mapped by VTM field crews between 1928 and 1940 (solid lines) compared to 1990 distribution as represented in the Gap Analysis database. Areas where the species occurred as a canopy co-dominant in the primary vegetation type (dark shading) and the secondary type (light shading) are shown. The digital VTM map was produced and described by Westman (1991).

*Priority communities and species.* Tables 3 and 4 list species and plant communities that we consider to be at risk based on the criteria defined above. Communities restricted largely to the lower elevations, such as non-native grasslands and the coastal sage scrub types, are clearly at considerable risk. Roughly 88% of areas below 500 m are in Level 3 management (i.e., privately owned). A majority of the lands at these elevations have already been converted to agricultural or urban uses and most of the remaining lands are threatened with future urbanization.

All extensive riparian communities, particularly those confined largely to low elevations such as mule fat scrub and southern arroyo willow, are already well known to be at risk (Bowler 1990), as are coastal wetlands (Ferren 1990). Conservation initiatives are already underway for most of these communities. Especially alarming is the condition of the California black walnut woodlands. The southern variety of this species is endemic to this region and its current dis-

TABLE 3. NATURAL COMMUNITIES IDENTIFIED AT RISK USING GAP ANALYSIS CRITERIA. Community codes are from NDDB. Communities are ordered from highest to lowest relative extent on private lands. Asterisks indicate community types whose mapped distribution totals less than 50 $km^2$. Other communities identified by the Natural Heritage Division as threatened or endangered but not detected by the Gap Analysis method are listed separately.

| Code | Natural community name |
|---|---|
| 71130 | Valley Oak Woodland* |
| 42110 | Valley Needlegrass Grassland* |
| 71210 | California Walnut Woodland |
| 37G00 | Coastal Sage–Chaparral Scrub |
| 71410 | Digger Pine–Oak Woodland* |
| 42200 | Non-Native Grassland |
| 32000 | Coastal Sage Scrub |
| 71160 | Coast Live Oak Woodland |
| 81310 | Coast Live Oak Forest |
| 71182 | Engelmann Oak Woodland |
| 37120 | Southern Mixed Chaparral |
| 37300 | Redshanks Chaparral |
| 35210 | Big Sagebrush Scrub |
| 37B00 | Upper Sonoran Manzanita Chaparral |
| 83330 | Southern Interior Cypress Forest* |
| 72210 | Mojavean Pinon Woodland* |
| 72110 | Northern Juniper Woodland |
| Other threatened or endangered plant communities | |
| 21330 | Southern Dune Scrub |
| 32400 | Maritime Succulent Scrub |
| 32720 | Riversidian Alluvial Fan Sage Scrub |
| 37C30 | Southern Maritime Chaparral |
| 42300 | Wildflower Field |
| 44310 | Southern Interior Basalt Flow Vernal Pool |
| 44321 | San Diego Mesa Hardpan Vernal Pool |
| 44322 | San Diego Mesa Claypan Vernal Pool |
| 47000 | Pebble Plains |
| 52120 | Southern Coastal Salt Marsh |
| 52200 | Coastal Brackish Marsh |
| 52410 | Coastal and Valley Freshwater Marsh |
| 61330 | Southern Cottonwood–Willow Riparian Forest |
| | Canyon Live Oak Ravine Forest |
| 62100 | Sycamore Alluvial Woodland |
| 62400 | Southern Sycamore–Alder Riparian Woodland |
| 63320 | Southern Willow Scrub |
| 63300 | Southern Riparian Scrub |
| 81820 | Mainland Cherry Forest |
| 83140 | Torrey Pine Forest |

tribution is highly fragmented and reduced compared with its original distribution.

Sagebrush steppe shrublands, although widespread elsewhere in California and other western states, appear vulnerable in this region. A significant proportion of the sagebrush steppe habitat is on Level

TABLE 4. DOMINANT PLANT SPECIES CONSIDERED AT RISK BASED ON GAP ANALYSIS CRITERIA. Species are grouped by community type with which they are most associated. * Fairly rare in this region but widespread in California, possibly rare associations in this region. ** Widespread taxon in California, but possibly rare ecotypes in this region. *** Rare local endemic, difficult to map at this level of resolution. **** Some associations are significantly underrepresented on Level 1 lands.

| | |
|---|---|
| Coastal Sage Scrub | Hardwood Forest/Woodland |
| *Eriogonum fasciculatum* | *Quercus agrifolia** |
| *Salvia apiana* | *Quercus engelmannii* |
| *Salvia leucophylla* | *Quercus kelloggii** |
| *Salvia mellifera* | *Quercus lobata** |
| *Malosma laurina* | *Juglans californica* |
| *Artemisia californica* | All riparian woodlands |
| *Encelia californica* | Conifer Forest/Woodland |
| Sagebrush Steppe Scrub | *Cupressus forbesii* |
| *Encelia farinosa** | *Juniperus occidentalis** |
| *Chrysothamnus nauseosus** | *Juniperus californica* |
| *Artemisia tridentata** | *Pinus sabiniana** |
| Chaparral Shrubs | |
| *Arctostaphylos glandulosa*** | |
| *Xylococcus bicolor* | |
| *Prunus illicifolia** | |
| *Ceanothus oliganthus* var. *sorediatus** | |
| *Ceanothus tomentosus* | |
| *Ceanothus verrucosus**** | |
| *Adenostoma sparsifolium***** | |

2 lands, and conservation concern for these communities can probably be adequately addressed by the public land managing agencies. Species and communities at higher elevations, especially montane chaparral and coniferous forest types, are generally well represented in Level 1 protected areas.

With the exception of canyon live oak and perhaps interior live oak, all other oak woodlands appear to be at risk now or over the next one or two decades. In contrast, most of the chaparral communities appear to be reasonably secure. They are generally found on steeper slopes, largely on public lands, and with at least 10% and often >20% in Level 1 status. However there are a wide variety of chaparral types in this region, and we should not take the conservation of all for granted. A number of chaparral species/communities are endemic or largely restricted to this region and there may be components of chaparral that may be at some risk.

*Priority areas for conservation planning.* Many different criteria have been used to prioritize areas for more detailed conservation planning and action, for example:

1. concentration of threatened and endangered taxa

2. concentration of threatened and endangered communities
3. concentration of narrowly endemic species
4. high taxonomic richness
5. high ecological diversity
6. extensive and/or well connected natural areas containing one or more taxa and/or communities of concern
7. areas that are environmentally or biotically distinctive or unique

Experience shows that the geographic distribution of priority areas can vary significantly depending on the criteria, the spatial scale of the analysis (e.g., Stoms 1992), and the taxonomic group(s) under consideration (e.g., Prendergast et al. 1993). Our Gap Analysis has identified relatively widespread upland plant species and communities that appear to be at risk as a function of land ownership and management status (criterion 6, above). We have not focused on locally endemic taxa nor on species already recognized as threatened or endangered. Figure 9 maps the density of threatened or endangered communities or plant taxa in 7.5 minute quadrangles, as represented in the California NDDB, as well as the percent of the quadrangle occupied by communities identified as at-risk by Gap Analysis. Patterns of the three criteria are quite distinctive, and only the Poway quad, which includes area between Poway and La Mesa in San Diego County, scores high on all three criteria. Western San Diego County, which has already undertaken an ambitious multi-species conservation planning effort, is striking for its concentration of threatened and endangered taxa and communities. The eastern edge of the region along the desert margin is distinctive for areas that contain concentrations of threatened taxa with low values for NDDB or Gap communities, while the northern region, notably the Santa Clara River Basin, contains many quads with large numbers of NDDB communities but low concentrations of NDDB plant taxa or Gap communities-at-risk.

From an ecosystem planning perspective, quads that contain high numbers of NDDB communities and where a large percentage is mapped by Gap Analysis as communities-at-risk seem likely candidates for new, extensive biodiversity management areas. These include the following quadrangles and areas:

- San Clemente, Canada Gobernadora and Oceanside quads (Santa Margarita River, Camp Pendleton)
- Beaumont quad (San Gorgonio Pass, foothills of San Bernardino and San Jacinto Mountains)
- Lake Mathews quad (Lake Mathews to Lake Elsinore)
- Piru, Simi, and Santa Susana quads (Santa Clara floodplain, Sespe and Piru Canyons, Oak Ridge to Santa Susana Mountains)
- Calabasas quad (Simi and Agoura Hills)

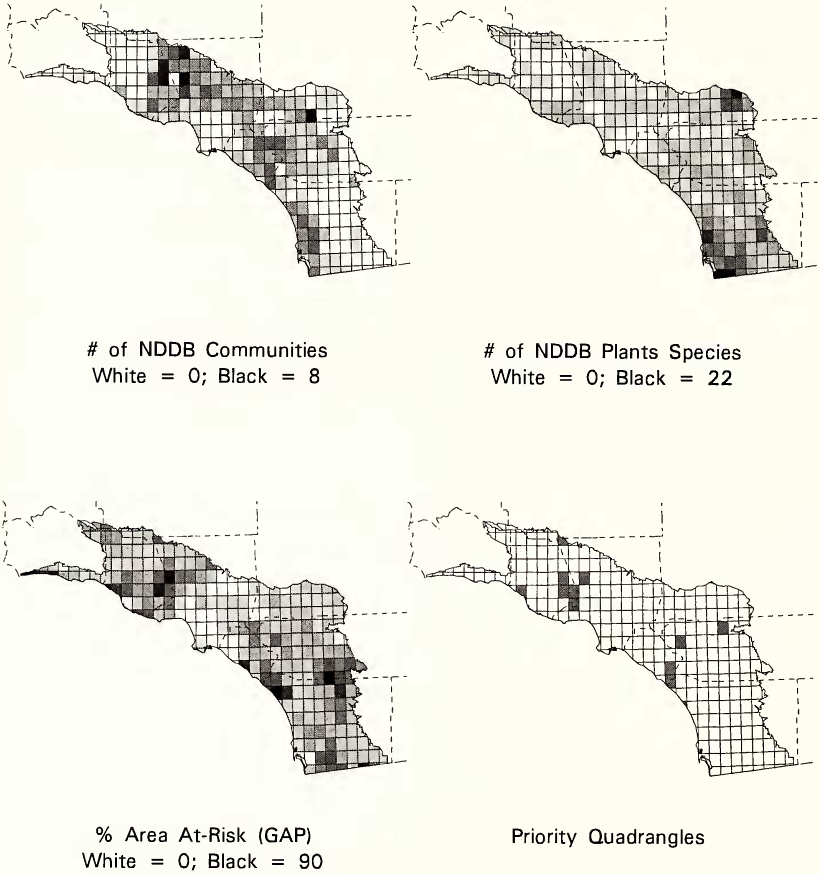


FIG. 9. Comparison of mapped patterns in three different conservation assessment criteria at the scale of 7.5 minute USGS quadrangle in the Southwestern California region. Criteria include 1) the number of plant communities at risk occurring in each quad, based on the California Natural Diversity Database (NDDB), 2) the number of threatened or endangered plant species occurring in each quad based on NDDB, 3) the percent of the quad occupied by plant communities deemed at risked as defined and mapped by Gap Analysis, and 4) quadrangles that rank highly in all three criteria for conservation activities.

- Ventura quad (lower Ventura River floodplain and surrounding slopes)
- Lebec quad (I5 corridor and slopes north of Castaic Lake to Grapevine (Tejon Pass))

The Nature Conservancy of California (TNC) recently conducted a conservation analysis of the Southwest region and identified priority areas based on the occurrence of 1) highly endangered species,

2) rare, threatened or declining communities, 3) large-landscape wildlife species, and 4) ensembles of three or more globally endangered species (California Nature Conservancy 1993). Using these criteria they identified 65 sites, 27 of which were considered critical for inclusion in a bioregional conservation strategy. Many of their sites fall within areas that are also of high priority based on the distribution of Gap communities-at-risk, especially in vicinity of Camp Pendleton, Otay Mesa in San Diego County, Lake Henshaw to Julian, and the western footslopes of the San Jacinto and Santa Rosa mountains. TNC sites that are also identified based on both NDDB community occurrence data and Gap Analysis data include the Santa Margarita River, San Mateo Creek, Miramar Mesa, Santa Clara floodplain near Fillmore, Sespe and Piru canyons, and Tejon Pass. The convergence of conservation priorities based on plant and animal species, threatened and endangered plant communities, and communities at risk, makes the case for immediate conservation action in these areas especially compelling.

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## APPENDIX A

Summary of the mapped distribution and management status of selected native, dominant species in California's Southwest Region. Statistics pertain to areas where the species was mapped as a canopy codominant (>20% of overstory cover), not the entire range of the species. Nomenclature follows the Jepson Manual. Geographic subregions include the Western Transverse Ranges (WT), South Coast (SC), San Gabriel Mountains (SG), San Bernardino Mountains (SB), San Jacinto Mountains (SJ), and Peninsular Range (PR). Land management status includes Level 1 (managed primarily for maintenance of biodiversity), Level 2 (public lands managed for multiple uses) and Level 3 (private lands not managed primarily for maintenance of biodiversity).

| | Subregion (%) | | | | | | Management level (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Species | WT | SC | SG | SB | SJ | PR | L1 | L2 | L3 | Area (sq. km) |
| Steppe Shrubs | | | | | | | | | | |
| *Artemisia tridentata* | 46 | 0 | 6 | 28 | 0 | 20 | 9 | 62 | 30 | 597 |
| *Chrysothamnus nauseosus* | 88 | 0 | 12 | 0 | 0 | 0 | 3 | 42 | 55 | 130 |
| *Chrysothamnus parryi* | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 93 | 7 | 78 |
| *Encelia farinosa* | 3 | 89 | 0 | 0 | 1 | 7 | 7 | 17 | 77 | 97 |
| *Ericameria linearifolia* | 68 | 0 | 3 | 0 | 0 | 29 | 0 | 18 | 82 | 100 |
| *Purshia glandulosa* | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 95 | 5 | 68 |
| *Purshia tridentata* | 82 | 0 | 0 | 0 | 0 | 18 | 0 | 56 | 44 | 38 |
| Soft Chaparral Shrubs | | | | | | | | | | |
| *Artemisia californica* | 32 | 23 | 2 | 0 | 0 | 43 | 5 | 21 | 74 | 2548 |
| *Encelia californica* | 15 | 77 | 0 | 0 | 0 | 8 | 4 | 8 | 89 | 200 |
| *Eriogonum fasciculatum* | 31 | 20 | 5 | 2 | 0 | 43 | 7 | 31 | 62 | 3610 |
| *Malosma laurina* | 29 | 5 | 1 | 0 | 0 | 65 | 2 | 40 | 58 | 393 |
| *Salvia apiana* | 11 | 19 | 3 | 3 | 1 | 63 | 7 | 33 | 60 | 1200 |
| *Salvia leucophylla* | 99 | 1 | 0 | 0 | 0 | 0 | 7 | 6 | 87 | 853 |
| *Salvia mellifera* | 55 | 24 | 2 | 0 | 0 | 19 | 6 | 22 | 72 | 1188 |
| *Yucca whipplei* | 11 | 19 | 3 | 3 | 1 | 63 | 7 | 33 | 60 | 1200 |
| Chaparral Shrubs | | | | | | | | | | |
| *Adenostoma fasciculatum* | 28 | 7 | 9 | 5 | 2 | 49 | 11 | 47 | 42 | 7969 |

APPENDIX A. CONTINUED.

| Species | Subregion (%) | | | | | | Management level (%) | | | Area (sq. km) |
|---|---|---|---|---|---|---|---|---|---|---|
| | WT | SC | SG | SB | SJ | PR | L1 | L2 | L3 | |
| *Adenostoma sparsifolium* | 4 | 0 | 0 | 0 | 1 | 95 | 11 | 47 | 42 | 1012 |
| *Arctostaphylos glandulosa* | 9 | 0 | 1 | 22 | 14 | 54 | 9 | 65 | 26 | 608 |
| *Arctostaphylos glauca* | 35 | 4 | 20 | 4 | 4 | 34 | 11 | 61 | 28 | 1358 |
| *Arctostaphylos parryana* | 100 | 0 | 0 | 0 | 0 | 0 | 41 | 38 | 21 | 12 |
| *Arctostaphylos patula* | 5 | 0 | 6 | 86 | 1 | 2 | 38 | 52 | 10 | 121 |
| *Arctostaphylos pringlei* | 0 | 0 | 0 | 0 | 100 | 0 | 89 | 0 | 11 | 12 |
| *Arctostaphylos pungens* | 0 | 0 | 0 | 0 | 0 | 100 | 15 | 22 | 63 | 90 |
| *Arctostaphylos tomentosa* | 22 | 0 | 38 | 4 | 2 | 34 | 14 | 64 | 22 | 494 |
| *Ceanothus cordulatus* | 11 | 0 | 15 | 66 | 9 | 0 | 52 | 39 | 9 | 132 |
| *Ceanothus crassifolius* | 25 | 9 | 25 | 6 | 0 | 35 | 18 | 46 | 36 | 2344 |
| *Ceanothus cuneatus* | 0 | 79 | 0 | 0 | 0 | 4 | 27 | 17 | 55 | 14 |
| *Ceanothus greggii* | 8 | 1 | 6 | 15 | 10 | 61 | 14 | 60 | 25 | 1379 |
| *Ceanothus integerrimus* | 0 | 0 | 41 | 59 | 0 | 0 | 36 | 40 | 24 | 43 |
| *Ceanothus leucodermis* | 7 | 0 | 28 | 13 | 6 | 47 | 18 | 60 | 23 | 1623 |
| *Ceanothus megacarpus* | 95 | 2 | 0 | 0 | 0 | 3 | 17 | 24 | 59 | 616 |
| *Ceanothus oliganthus* | 19 | 1 | 28 | 0 | 0 | 52 | 20 | 50 | 30 | 549 |
| *Ceanothus palmeri* | 0 | 0 | 0 | 0 | 0 | 100 | 9 | 84 | 8 | 20 |
| *Ceanothus sorediatus* | 0 | 9 | 0 | 0 | 0 | 91 | 0 | 38 | 62 | 113 |
| *Ceanothus spinosus* | 88 | 2 | 0 | 0 | 1 | 9 | 17 | 35 | 48 | 552 |
| *Ceanothus tomentosus* | 0 | 0 | 0 | 0 | 0 | 100 | 2 | 44 | 54 | 130 |
| *Ceanothus verrucosus* | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 16 |
| *Cercocarpus betuloides* | 38 | 1 | 17 | 10 | 3 | 31 | 20 | 62 | 18 | 2945 |
| *Cercocarpus ledifolius* | 0 | 0 | 20 | 18 | 0 | 62 | 7 | 86 | 7 | 24 |
| *Chrysolepis sempervirens* | 0 | 0 | 16 | 69 | 15 | 0 | 53 | 37 | 10 | 139 |
| *Fraxinus dipetala* | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 88 | 13 | 28 |
| *Fremontodendron californicum* | 0 | 0 | 67 | 33 | 0 | 0 | 12 | 82 | 6 | 74 |

Appendix A. Continued.

| Species | Subregion (%) | | | | | | Management level (%) | | | Area (sq. km) |
|---|---|---|---|---|---|---|---|---|---|---|
| | WT | SC | SG | SB | SJ | PR | L1 | L2 | L3 | |
| *Heteromeles arbutifolia* | 6 | 6 | 4 | 0 | 0 | 84 | 10 | 47 | 43 | 85 |
| *Prunus illicifolia* | 88 | 1 | 12 | 0 | 0 | 0 | 3 | 69 | 28 | 132 |
| *Quercus chrysolepis* | 21 | 0 | 27 | 33 | 2 | 16 | 28 | 61 | 11 | 451 |
| *Quercus dumosa* (per Munz) | 39 | 2 | 12 | 10 | 1 | 36 | 16 | 54 | 29 | 4534 |
| *Quercus wislizenii* | 27 | 0 | 30 | 22 | 6 | 15 | 25 | 61 | 15 | 1422 |
| *Rhus integrifolia* | 33 | 16 | 15 | 0 | 0 | 35 | 11 | 29 | 60 | 470 |
| *Rhus ovata* | 0 | 1 | 17 | 8 | 0 | 74 | 22 | 32 | 46 | 263 |
| *Symphoricarpos mollis* | 92 | 0 | 8 | 0 | 0 | 0 | 38 | 48 | 14 | 12 |
| *Xylococcus bicolor* | 0 | 6 | 0 | 0 | 0 | 94 | 3 | 39 | 57 | 219 |
| Broadleaf Trees | | | | | | | | | | |
| *Aesculus californica* | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 67 | 33 | 8 |
| *Arbutus menziesii* | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 41 | 59 | 8 |
| *Juglans californica* | 60 | 9 | 0 | 0 | 0 | 31 | 3 | 8 | 89 | 60 |
| *Quercus agrifolia* | 22 | 4 | 1 | 1 | 1 | 72 | 8 | 30 | 62 | 728 |
| *Quercus chrysolepis* | 20 | 0 | 31 | 24 | 3 | 23 | 31 | 53 | 16 | 784 |
| *Quercus douglasii* | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 33 | 67 | 6 |
| *Quercus engelmannii* | 0 | 0 | 0 | 0 | 0 | 100 | 3 | 32 | 65 | 236 |
| *Quercus kelloggii* | 2 | 0 | 5 | 31 | 7 | 55 | 9 | 50 | 41 | 457 |
| *Quercus lobata* | 100 | 1 | 0 | 0 | 0 | 0 | 2 | 7 | 91 | 50 |
| *Quercus wislizenii* | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 100 | 0 | 53 |
| Conifer Trees | | | | | | | | | | |
| *Abies concolor* | 13 | 0 | 17 | 52 | 9 | 9 | 31 | 52 | 17 | 788 |
| *Calocedrus decurrens* | 0 | 0 | 3 | 64 | 14 | 19 | 13 | 73 | 14 | 140 |
| *Cupressus forbesii* | 0 | 0 | 0 | 0 | 0 | 100 | 7 | 70 | 22 | 18 |
| *Juniperus californica* | 90 | 0 | 9 | 0 | 0 | 1 | 16 | 56 | 28 | 733 |

Appendix A. Continued.

| Species | Subregion (%) | | | | | | Management level (%) | | | Area (sq. km) |
|---|---|---|---|---|---|---|---|---|---|---|
| | WT | SC | SG | SB | SJ | PR | L1 | L2 | L3 | |
| *Juniperus occidentalis* | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 96 | 4 | 96 |
| *Pinus attenuata* | 0 | 0 | 42 | 59 | 0 | 0 | 0 | 90 | 10 | 15 |
| *Pinus contorta* | 0 | 0 | 14 | 79 | 7 | 0 | 83 | 14 | 3 | 59 |
| *Pinus coulteri* | 2 | 0 | 15 | 18 | 15 | 50 | 22 | 52 | 26 | 378 |
| *Pinus flexilis* | 0 | 0 | 1 | 88 | 11 | 0 | 91 | 9 | 0 | 45 |
| *Pinus jeffreyi* | 22 | 0 | 15 | 49 | 2 | 13 | 25 | 63 | 12 | 958 |
| *Pinus lambertiana* | 17 | 0 | 36 | 27 | 11 | 10 | 42 | 49 | 10 | 356 |
| *Pinus monophylla* | 73 | 0 | 6 | 20 | 0 | 1 | 14 | 73 | 13 | 1066 |
| *Pinus ponderosa* | 12 | 0 | 31 | 29 | 19 | 9 | 38 | 39 | 23 | 361 |
| *Pinus sabiniana* | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 84 | 15 |
| *Pseudotsuga macrocarpa* | 25 | 0 | 43 | 24 | 0 | 9 | 35 | 54 | 11 | 43 |

## Appendix B

Summary of the distribution and land ownership status of natural plant communities in California's Southwest Region. Communities are defined as in Holland (1986). Geographic subregions include the Western Transverse Ranges (WT), South Coast (SC), San Gabriel Mountains (SG), San Bernardino Mountains (SB), San Jacinto Mountains (SJ), and Peninsular Range (PR). Land management status includes Level 1 (managed primarily for maintenance of biodiversity), Level 2 (public lands managed for multiple uses) and Level 3 (private lands not managed primarily for maintenance of biodiversity). The mapped area for each community type is provided in square kilometers.

| Community | Holland code | Subregion (%) | | | | | | Management level (%) | | | Area (sq. km) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | WT | SC | SG | SB | SJ | PR | L1 | L2 | L3 | |
| Scrub | | | | | | | | | | | |
| Coastal Scrub | 32000 | 41 | 22 | 2 | 1 | 0 | 34 | 7 | 22 | 71 | 3908 |
| Mojave Creosote Scrub | 34100 | 0 | 0 | 0 | 73 | 0 | 27 | 33 | 39 | 28 | 86 |
| Big Sagebrush Scrub | 35210 | 46 | 0 | 3 | 26 | 0 | 26 | 3 | 59 | 38 | 334 |
| Chaparral | | | | | | | | | | | |
| Northern Mixed Chaparral | 37110 | 35 | 4 | 5 | 7 | 3 | 46 | 6 | 57 | 37 | 1143 |
| Southern Mixed Chaparral | 37120 | 1 | 10 | 0 | 0 | 0 | 89 | 3 | 35 | 62 | 219 |
| Chamise Chaparral | 37200 | 35 | 12 | 2 | 4 | 0 | 46 | 10 | 36 | 54 | 1407 |
| Redshank Chaparral | 37300 | 2 | 0 | 0 | 0 | 1 | 96 | 10 | 48 | 42 | 950 |
| Semi-desert Chaparral | 37400 | 5 | 0 | 8 | 8 | 9 | 70 | 18 | 59 | 24 | 1025 |
| Mixed Montane Chaparral | 37510 | 19 | 0 | 28 | 45 | 4 | 4 | 49 | 41 | 10 | 187 |
| Montane Manzanita Chaparral | 37520 | 0 | 0 | 0 | 0 | 0 | 100 | 5 | 58 | 37 | 13 |
| Deer Brush Chaparral | 37531 | 0 | 0 | 22 | 78 | 0 | 0 | 20 | 31 | 49 | 17 |
| Whitethorn Chaparral | 37532 | 7 | 0 | 26 | 2 | 0 | 64 | 11 | 62 | 28 | 337 |
| Buck Brush Chaparral | 37810 | 66 | 8 | 0 | 0 | 0 | 26 | 17 | 40 | 43 | 709 |
| *Ceanothus crassifolius* Chaparral | 37830 | 21 | 10 | 26 | 7 | 0 | 37 | 15 | 48 | 37 | 2045 |
| *Ceanothus megacarpus* Chaparral | 37840 | 96 | 2 | 0 | 0 | 0 | 2 | 18 | 25 | 57 | 572 |
| Scrub Oak Chaparral | 37900 | 32 | 1 | 14 | 10 | 1 | 41 | 22 | 56 | 23 | 1644 |
| Interior Live Oak Chaparral | 37A00 | 28 | 0 | 32 | 24 | 5 | 11 | 25 | 62 | 13 | 1174 |
| Upper Sonoran Manzanita Chaparral | 37B00 | 30 | 5 | 9 | 10 | 14 | 33 | 6 | 70 | 24 | 381 |

APPENDIX B. CONTINUED.

| Community | Holland code | Subregion (%) | | | | | | Management level (%) | | | Area (sq. km) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | WT | SC | SG | SB | SJ | PR | L1 | L2 | L3 | |
| Southern North Slope Chaparral | 37E00 | 66 | 0 | 12 | 11 | 0 | 12 | 55 | 44 | 1 | 14 |
| Coastal Sage–Chaparral Scrub | 37G00 | 7 | 27 | 4 | 0 | 0 | 61 | 1 | 17 | 82 | 64 |
| Herbaceous | | | | | | | | | | | |
| Valley Needlegrass | 42110 | 0 | 0 | 0 | 0 | 0 | 100 | 6 | 1 | 93 | 3 |
| Non-native Grassland | 42200 | 31 | 19 | 0 | 1 | 0 | 49 | 6 | 21 | 73 | 1165 |
| Southern Coastal Salt Marsh | 52120 | 0 | 82 | 0 | 0 | 0 | 0 | 28 | 14 | 57 | 13 |
| Coastal Brackish Marsh | 52200 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 1 |
| Coastal/Valley Freshwater Marsh | 52410 | 0 | 15 | 0 | 0 | 0 | 84 | 5 | 21 | 74 | 40 |
| Riparian Woodland | | | | | | | | | | | |
| S. Coast Live Oak Riparian | 61310 | 63 | 9 | 0 | 0 | 3 | 25 | 16 | 46 | 38 | 26 |
| S. Arroyo Willow Riparian | 61320 | 12 | 49 | 0 | 11 | 0 | 28 | 4 | 36 | 60 | 37 |
| S. Cottonwood–Willow Riparian | 61330 | 22 | 24 | 4 | 32 | 0 | 19 | 7 | 45 | 48 | 59 |
| White Alder Riparian | 61510 | 60 | 0 | 7 | 20 | 0 | 13 | 17 | 36 | 47 | 8 |
| S. Sycamore–Alder Riparian | 62400 | 14 | 1 | 0 | 0 | 0 | 85 | 7 | 28 | 65 | 17 |
| Mule Fat Scrub | 63310 | 31 | 57 | 0 | 0 | 0 | 13 | 5 | 35 | 60 | 45 |
| Southern Willow Scrub | 63320 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 12 | 88 | 1 |
| Southern Alluvial Fan Scrub | 63330 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 98 | 13 |
| Broadleaved Woodland | | | | | | | | | | | |
| Valley Oak Woodland | 71130 | 99 | 1 | 0 | 0 | 0 | 0 | 3 | 3 | 94 | 36 |
| Blue Oak Woodland | 71140 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 89 | 4 |
| Interior Live Oak Woodland | 71150 | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 100 | 0 | 14 |
| Coast Live Oak Woodland | 71160 | 29 | 1 | 4 | 0 | 0 | 67 | 0 | 29 | 71 | 60 |

APPENDIX B. CONTINUED.

| Community | Holland code | Subregion (%) | | | | | | Management level (%) | | | Area (sq. km) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | WT | SC | SG | SB | SJ | PR | L1 | L2 | L3 | |
| Dense Engelmann Oak Woodland | 71182 | 0 | 0 | 0 | 0 | 0 | 100 | 3 | 30 | 66 | 226 |
| California Walnut Woodland | 71210 | 57 | 10 | 0 | 0 | 0 | 33 | 3 | 8 | 89 | 56 |
| Conifer Woodland | | | | | | | | | | | |
| Non-Serpentine Digger Pine–Chaparral | 71322 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 4 |
| Digger Pine–Oak Woodland | 71410 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 76 | 9 |
| Northern Juniper Woodland | 72110 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 96 | 4 | 95 |
| Mojavean Pinon Woodland | 72210 | 0 | 0 | 66 | 34 | 0 | 0 | 0 | 94 | 6 | 62 |
| Peninsular Pinon Woodland | 72310 | 68 | 0 | 8 | 22 | 0 | 3 | 11 | 71 | 18 | 346 |
| Peninsular Juniper Woodland/Scrub | 72320 | 58 | 0 | 0 | 0 | 0 | 43 | 39 | 43 | 18 | 23 |
| Cuyaman Pinyon Woodland | 72500 | 87 | 0 | 10 | 4 | 0 | 0 | 14 | 62 | 24 | 939 |
| Broadleaved Forest | | | | | | | | | | | |
| Mixed Evergreen Forest | 81100 | 4 | 0 | 7 | 5 | 0 | 84 | 22 | 57 | 21 | 54 |
| Coast Live Oak Forest | 81310 | 45 | 8 | 0 | 0 | 0 | 46 | 8 | 22 | 70 | 172 |
| Canyon Live Oak Forest | 81320 | 32 | 0 | 27 | 11 | 10 | 21 | 37 | 49 | 14 | 121 |
| Interior Live Oak Forest | 81330 | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 100 | 0 | 38 |
| Black Oak Forest | 81340 | 2 | 1 | 0 | 23 | 7 | 67 | 16 | 56 | 28 | 202 |
| Conifer Forest | | | | | | | | | | | |
| Knobcone Pine Forest | 83210 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 92 | 8 | 5 |
| Southern Interior Cypress Forest | 83330 | 0 | 0 | 0 | 0 | 0 | 100 | 7 | 70 | 22 | 17 |
| Coulter Pine Forest | 84140 | 3 | 0 | 19 | 21 | 8 | 49 | 14 | 59 | 27 | 295 |
| Bigcone Spruce/Canyon Live Oak | 84150 | 33 | 0 | 50 | 15 | 0 | 2 | 46 | 46 | 7 | 314 |
| Westside Ponderosa Pine Forest | 84210 | 14 | 0 | 28 | 34 | 16 | 8 | 44 | 35 | 21 | 308 |

APPENDIX B. CONTINUED.

| Community | Holland code | Subregion (%) | | | | | | Management level (%) | | | Area (sq. km) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | WT | SC | SG | SB | SJ | PR | L1 | L2 | L3 | |
| Sierran Mixed Conifer Forest | 84230 | 15 | 0 | 47 | 18 | 9 | 11 | 32 | 55 | 13 | 199 |
| Jeffrey Pine Forest | 85100 | 31 | 0 | 14 | 31 | 5 | 18 | 21 | 66 | 13 | 236 |
| Jeffrey Pine–Fir Forest | 85210 | 19 | 0 | 2 | 74 | 0 | 5 | 23 | 64 | 13 | 360 |
| S. California White Fir Forest | 85320 | 4 | 0 | 10 | 51 | 36 | 0 | 35 | 53 | 13 | 38 |
| Lodgepole Pine Forest | 86100 | 0 | 0 | 58 | 42 | 0 | 0 | 49 | 36 | 15 | 4 |
| S. California Subalpine Forest | 86500 | 0 | 0 | 3 | 81 | 16 | 0 | 92 | 8 | 0 | 52 |
| Total | | 25 | 31 | 7 | 7 | 1 | 29 | 10 | 31 | 60 | 33832 |